

WHAT IS CLAIMED IS:

1. A lateral semiconductor device comprising:
 - a first conductivity type base layer having resistance higher than that of a first conductivity type buffer layer;
 - said first conductivity type buffer layer selectively formed in the surface portion of said first conductivity type base layer;
 - a second conductivity type drain layer selectively formed in the surface portion of said first conductivity type buffer layer;
 - a second conductivity type base layer selectively formed in the surface portion of said first conductivity type base layer so as to surround said first conductivity type buffer layer with a spacing therebetween;
 - a first conductivity type source layer selectively formed in the surface portion of said second conductivity type base layer;
 - a gate electrode formed via a gate insulating film on the surface of said second conductivity type base layer sandwiched between said first conductivity type base layer and said first conductivity type source layer;
 - a source electrode in contact with said second conductivity type base layer and said first conductivity type source layer; and
 - a drain electrode in contact with said second conductivity type drain layer,wherein said second conductivity type drain layer has a structure in which said first conductivity type buffer layer not in contact with said drain electrode is exposed in a portion of said second conductivity type drain layer.
2. A device according to claim 1, wherein
 - said first conductivity type buffer layer has a striped shape having two end portions protruding outward into the shape of an arc;
 - the inner circumferential surface of said second conductivity type base layer has the same shape as said first conductivity type buffer layer;

said first conductivity type source layer has a striped shape selectively formed to oppose a straight portion of the stripe of said first conductivity type buffer layer; and

said second conductivity type drain layer has an annular structure whose inner and outer circumferential surfaces have the same shape as said first conductivity type buffer layer, and said first conductivity type buffer layer not in contact with said drain electrode is exposed inside the annular structure.

3. A device according to claim 2, wherein said first conductivity type drain layer having an annular structure, horseshoe-shaped structure, or U-shaped structure comprises an aggregate of a plurality of rectangular drain layer portions.

4. A device according to claim 2, wherein said second conductivity type drain layer is shifted to said first conductivity type source layer in the widthwise direction of said first conductivity type buffer layer.

5. A device according to claim 1, wherein
said first conductivity type buffer layer has a striped shape having two end portions protruding outward into the shape of an arc;

the inner circumferential surface of said second conductivity type base layer has the same shape as said first conductivity type buffer layer;

said first conductivity type source layer has a striped shape selectively formed to oppose a straight portion of the stripe of said first conductivity type buffer layer; and

said second conductivity type drain layer has a horseshoe-shaped structure or U-shaped structure, and said first conductivity type buffer layer not in contact with said drain electrode is exposed inside the horseshoe-shaped structure or U-shaped structure.

6. A device according to claim 5, wherein said first conductivity type drain layer having an annular structure, horseshoe-shaped structure, or U-shaped structure comprises an aggregate of a plurality of rectangular drain layer

portions.

7. A device according to claim 5, wherein said second conductivity type drain layer is shifted to said first conductivity type source layer in the widthwise direction of said first conductivity type buffer layer.

8. A device according to claim 1, wherein
said first conductivity type buffer layer has a striped shape having two end portions protruding outward into the shape of an arc;

the inner circumferential surface of said second conductivity type base layer has the same shape as said first conductivity type buffer layer;

said first conductivity type source layer has a striped shape selectively formed to oppose a straight portion of the stripe of said first conductivity type buffer layer; and

said second conductivity type drain layer has a plurality of juxtaposed stripe structures, and said first conductivity type buffer layer not in contact with said drain electrode is exposed between the stripes.

9. A device according to claim 8, wherein said second conductivity type drain layer is shifted to said first conductivity type source layer in the widthwise direction of said first conductivity type buffer layer.

10. A device according to claim 1, wherein

said first conductivity type buffer layer has a striped shape having two end portions protruding outward into the shape of an arc;

the inner circumferential surface of said second conductivity type base layer has the same shape as said first conductivity type buffer layer;

said first conductivity type source layer has a striped shape selectively formed to oppose a straight portion of the stripe of said first conductivity type buffer layer; and

said second conductivity type drain layer has a plurality of juxtaposed stripe structures, each stripe comprises an aggregate of a plurality of rectangular drain layer portions, and said first conductivity type buffer layer

not in contact with said drain electrode is exposed between the stripes and between the rectangles.

11. A device according to claim 10, wherein said second conductivity type drain layer is shifted to said first conductivity type source layer in the widthwise direction of said first conductivity type buffer layer.

12. A device according to claim 1, wherein

said first conductivity type buffer layer has a striped shape having two, upper and lower end portions protruding outward into the shape of an arc;

the inner circumferential surface of said second conductivity type base layer has the same shape as said first conductivity type buffer layer;

said first conductivity type source layer has a striped shape selectively formed to oppose a straight portion of the stripe of said first conductivity type buffer layer; and

said second conductivity type drain layer comprises a plurality of linearly arranged rectangular drain layer portions, and said first conductivity type buffer layer not in contact with said drain electrode is exposed between adjacent drain layer portions.

13. A device according to claim 12, wherein the rectangular drain layer portions of said second conductivity type drain layer are long along the widthwise direction of said first conductivity type buffer layer.

14. A vertical semiconductor device comprising:

a first conductivity type base layer having resistance higher than that of a first conductivity type buffer layer;

said first conductivity type buffer layer formed in one surface portion of said first conductivity type base layer;

a second conductivity type drain layer selectively formed in a surface portion of said first conductivity type buffer layer;

a second conductivity type base layer selectively formed in the other surface portion of said first conductivity type base layer;

a first conductivity type source layer selectively

formed in a surface portion of said second conductivity type base layer;

a gate insulating film formed on said second conductivity type base layer between said first conductivity type source layer and said first conductivity type base layer;

a gate electrode formed on said second conductivity type base layer via said gate insulating film;

a drain electrode electrically connected to said second conductivity type drain layer; and

a source electrode electrically connected to said first conductivity type source layer and said second conductivity type base layer,

wherein said drain electrode is not electrically connected to said first conductivity type buffer layer.

15. A device according to claim 14, wherein a surface impurity concentration C_s of said second conductivity type drain layer satisfies

$$C_s > 1 \times 10^{19} \text{ cm}^{-3}.$$

16. A device according to claim 14, wherein a barrier metal layer is formed between said drain electrode and said second conductivity type drain layer.

17. A vertical semiconductor device comprising:

a first conductivity type base layer having resistance higher than that of a first conductivity type buffer layer;

said first conductivity type buffer layer formed in one surface portion of said first conductivity type base layer;

a plurality of trenches formed in the other surface portion of said first conductivity type base layer;

a second conductivity type base layer formed to be shallower than said trenches, in the other surface portion of said first conductivity type base layer;

a first conductivity type source layer formed on the two sides of each trench, in a surface portion of said second conductivity type base layer;

a gate insulating film formed on the side walls and bottom surfaces of said trenches;

a gate electrode formed via said gate insulating film

so as to fill said trenches;

a source electrode electrically connected to said first conductivity type source layer and said second conductivity type base layer;

a second conductivity type drain layer selectively formed in a surface portion of said first conductivity type buffer layer; and

a drain electrode electrically connected to said second conductivity type drain layer,

wherein said drain electrode is not electrically connected to said first conductivity type buffer layer.

18. A device according to claim 17, wherein a surface impurity concentration C_s of said second conductivity type drain layer satisfies

$$C_s > 1 \times 10^{19} \text{ cm}^{-3}.$$

19. A device according to claim 17, wherein a barrier metal layer is formed between said drain electrode and said second conductivity type drain layer.

20. A vertical semiconductor device comprising:

a first conductivity type semiconductor substrate having resistance higher than that of a first conductivity type buffer layer;

said first conductivity type buffer layer formed in one surface portion of said first conductivity type semiconductor substrate;

a plurality of first trenches formed in the other surface portion of said first conductivity type semiconductor substrate;

a second conductivity type base layer formed to be shallower than said first trenches, in the other surface portion of said first conductivity type semiconductor substrate;

a first conductivity type source layer formed on the two sides of each first trench, in a surface portion of said second conductivity type base layer;

a first insulating film formed on the side walls and bottom surfaces of said first trenches;

a gate electrode formed inside said first trenches via said first insulating film so as to fill said first trenches;

a source electrode connected to said first conductivity type source layer and said second conductivity type base layer;

a second trench formed in said first conductivity type buffer layer;

a second insulating film formed on the side walls of said second trench;

a second conductivity type first drain layer formed in a bottom surface portion of said second trench;

a second conductivity type second drain layer formed to be shallower than said second trench, in a surface portion of said first conductivity type buffer layer;

a buried drain electrode formed inside said second trench via said second insulating film so as to fill said second trench, and connected to said second conductivity type first drain layer; and

a drain electrode connected to said second conductivity type second drain layer and said buried drain electrode.

21. A vertical semiconductor device comprising:

a first conductivity type semiconductor substrate having resistance higher than that of a first conductivity type buffer layer;

said first conductivity type buffer layer formed in one surface portion of said first conductivity type semiconductor substrate;

a second conductivity type base layer selectively formed in the other surface portion of said first conductivity type semiconductor substrate;

a first conductivity type source layer selectively formed in a surface portion of said second conductivity type base layer;

a gate insulating film formed on said second conductivity type base layer between said first conductivity type source layer and said first conductivity type semiconductor substrate;

a gate electrode formed on said second conductivity type base layer via said gate insulating film;

a source electrode connected to said first conductivity type source layer and said second conductivity type base layer;

a trench formed in said first conductivity type buffer layer;

an insulating film formed on the side walls of said trench;

a second conductivity type first drain layer formed in a bottom surface portion of said trench;

a second conductivity type second drain layer formed to be shallower than said trench, in a surface portion of said first conductivity type buffer layer;

a buried drain electrode formed inside said trench via said insulating film so as to fill said trench, and connected to said second conductivity type first drain layer; and

a drain electrode connected to said second conductivity type second drain layer and said buried drain electrode.